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Remarks

Thorough examination by the Examiner is noted and appreciated.

The claims have been amended to clarify Applicants invention and correct grammatical errors.

Support for the amendments is found in the original claims and in the Specification. No new matter has been added.

For example, support for the amendments is found in the original claims and in the Specification, for example, at paragraph 0026:

"The second plasma treatment includes an oxygen containing plasma and is preferably carried out in-situ following the first plasma treatment, but may also be carried out in a separate plasma reactor, however, preferably in-situ with respect to at least a subsequent overlying etch stop layer deposition process explained below. The second plasma treatment preferably includes a plasma source gas including at least O<sub>2</sub>, for example O<sub>2</sub> and a mixture of another oxygen containing gas such as CO, CO<sub>2</sub>, NO, N<sub>2</sub>O, and O<sub>3</sub>. Most preferably, due to considerations of cost, and ease of use, and effectiveness, a mixture of O<sub>2</sub> and CO<sub>2</sub> is used as the plasma source gas, for example supplied individually or pre-mixed at ratio of O<sub>2</sub> to CO<sub>2</sub> of about 1:5 to about 1:20."

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Claim Rejections under 35 USC 102

1. Claims 1, 8, 9, and 12 stand rejected under 35 USC 102(e) as being anticipated by Noguchi et al. (USPUB 2004/0152256).

Noguchi et al. discloses a process where a process surface having an exposed copper portion and an exposed dielectric insulating layer portion are treated with a plasma treatment of  $\text{NH}_3$  or alternatively  $\text{N}_2/\text{H}_2$  (see paragraph 0077) to reduce copper oxide and form a thin  $\text{CuN}$  layer over the exposed copper (see paragraph 0077). After cleaning the process wafer, Noguchi et al. teach **then forming** a barrier insulation film disclosed to be  $\text{SiN}$ ,  $\text{SiC}$ ,  $\text{SiCN}$ ,  $\text{SiON}$ , and  $\text{SiOC}$ , is deposited over the surface (paragraph 0076).

Thus, Noguchi et al. do not disclose several aspects of Applicants disclosed and claimed invention, including:

plasma treating the process surface in a first plasma treatment with plasma comprising reduction gas and nitriding gas; and,

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then plasma treating the process surface in a second plasma treatment comprising oxidizing gas, said second plasma treatment performed without deposition of a material layer.

Noguchi et al. is clearly insufficient to anticipate Applicants disclosed and claimed invention.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdugaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

2. Claim 1 stands rejected under 35 USC 102(e) as being anticipated by Ngo et al. (USPUB 2002/0162736).

Ngo disclose a method for forming a dual damascene where copper exposed at the bottom of a dual damascene opening is treated with NH3 followed by a N2/H2 plasma treatment to remove oxide from the copper surface and to remove residual polymers within the opening generated by etching the opening, and then Ar

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sputter etching prior to depositing a barrier layer to line the opening (see Abstract; paragraph 0025-0028). Ngo further disclose removing the photoresist mask used to etch the dual damascene opening prior to the sequential NH3 and N2/H2 plasma treatments (see paragraph 0024).

Thus, Ngo et al. do not disclose several aspects of Applicants disclosed and claimed invention, including:

plasma treating the process surface in a first plasma treatment with plasma comprising reduction gas and nitriding gas; and,

then plasma treating the process surface in a second plasma treatment comprising oxidizing gas, said second plasma treatment performed without deposition of a material layer.

Ngo et al. is clearly insufficient to anticipate Applicants disclosed and claimed invention.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Vordegaa Bros. v.*

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*Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051,  
1053 (Fed. Cir. 1987).

Claim Rejections under 35 USC 103

3. Claim 2 stands rejected under 35 USC 103(a) as being unpatentable over Noguchi et al., above, in view of Bao et al. (US 6,248,665).

Applicants reiterate the comments made above with respect to Noguchi et al.

The fact that Bao et al. teach pre-heating a copper structure following a polishing process and prior to plasma treating the copper with NH<sub>3</sub> (see Abstract) does not further help Examiner in establishing a *prima facie* case of obviousness.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

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4. Claim 3 stands rejected under 35 USC 103(a) as being unpatentable over Noguchi et al., above, in view of Inukai et al. (USPUH 2004/0152256).

Applicants reiterate the comments made above with respect to Noguchi et al.

The fact that Inukai et al. teach an ashing process for removing resist with a reducing gas following an etching a contact hole to expose copper at the bottom of the contact hole where the ashing process is carried out using a reduction gas comprising NH<sub>3</sub> and H<sub>2</sub> does not further help Examiner in establishing a *prima facie* case of obviousness.

It is noted that the ashing process of Inukai et al. and Noguchi et al. work by a different principle of operation.

Nevertheless, even assuming *arguendo* a proper motivation for combination, such combination does not produce Applicants disclosed and claimed invention.

"Finally, the prior art reference (or references when

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combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

5. Claim 5 stands rejected under 35 USC 103(a) as being unpatentable over Noguchi et al., above.

Applicants reiterate the comments made above with respect to Noguchi et al.

As noted above, Noguchi et al. a plasma treatment of NH3 or alternatively N2/H2 (see paragraph 0077) and further does not disclose Applicants second plasma treatment.

6. Claim 7 stands rejected under 35 USC 103(a) as being unpatentable over Ngo et al., above, in view of Hsieh et al. (USPUB 2003/0164354).

Applicants reiterate the above comments made with respect to Ngo et al.

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The fact that Hsieh et al. teach removing photoresist from a porous low-K dielectric using a plasma consisting essentially of O<sub>2</sub>, followed by etching through a barrier layer (see Abstract) does not further help Examiner in establishing a *prima facie* case of obviousness.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

7. Claims 10, 11, and 13 stand rejected under 35 USC 103(a) as being unpatentable over Noguchi et al., above, in view of Buchwaller et al. (US 6,261,951).

Applicants reiterate the above comments made with respect to Noguchi et al.

The fact that Buchwaller et al. teach exposing an interconnect semiconductor structure containing at least a layer of copper to a reducing plasma (H<sub>2</sub>, N<sub>2</sub>, NH<sub>3</sub>) under conditions



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such that a material layer comprising Cu, Si and O is formed on the layer of copper (see e.g., claims 1 and 2) does not further help Examiner in establishing a *prima facie* case of obviousness.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaack*, 917 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

8. Claims 14, 20, and 21 stand rejected under 35 USC 103(a) as being unpatentable over Ngo et al., above, in view of Buchwalter et al., above.

Applicants reiterate the above comments made with respect to Ngo et al. and Buchwalter et al., above.

9. Claim 15 stands rejected under 35 USC 103(a) as being unpatentable over Ngo et al., in view of Buchwalter et al., above and further in view of Bao et al.

Applicants reiterate the comments made above with respect to

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Ngo et al., Buchwalter et al., and Bao et al.

10. Claim 18 stands rejected under 35 USC 103(a) as being unpatentable over Ngo et al., in view of Buchwalter et al., above and further in view of Hsieh et al., above.

Applicants reiterate the comments made above with respect to Ngo et al., Buchwalter et al., and Hsieh et al.

11. Claim 22 stands rejected under 35 USC 103(a) as being unpatentable over Ngo et al., in view of Buchwalter et al., above and further in view of Zistl et al., above.

Applicants reiterate the comments made above with respect to Ngo et al. and Buchwalter et al.

The fact that Zistl et al. teach a process where an "exposed copper surface is first cleaned by a reactive plasma ambient including nitrogen and ammonia and after a certain clean period, a gaseous compound comprising silicon, for example silane, is added to the reactive plasma ambient to form the copper/silicon film" (see Abstract) does not further help Examiner in establishing a *prima facie* case of obviousness.

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"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vacck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Applicants note with appreciation Examiner indication of allowable subject matter in claims 4, 6, and 17.

However, the cited references, alone or in combination, do not produce Applicants disclosed and claimed invention and therefore do not make out a *prima facie* case of obviousness with respect to Applicants disclosed and claimed invention.

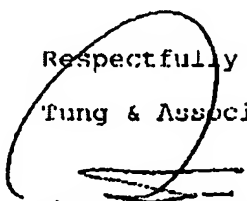
Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in condition for allowance for any reason, the Examiner is

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respectfully invited to call the Applicants' representative at his  
Bloomfield Hills, Michigan office at (248) 540-4040 such that  
necessary action may be taken to place the application in a  
condition for allowance.

Respectfully submitted,  
Tung & Associates

  
\_\_\_\_\_  
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